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RANGING BEHAVIOR OF LONG-TAILED MACAQUES (*Macaca fascicularis*) AT THE ENTRANCE OF KUALA SELANGOR NATURE PARK

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ABSTRACT

This study reported the ranging behavior of a group of long-tailed macaques (*Macaca fascicularis*) that inhabit the area near Kuala Selangor Nature Park, Selangor, Malaysia. The data on the ranging behavior were collected daily through scan sampling from February to December 2011 on all significant individuals in the focus group. Observations were focusing on the moving distance and usage of canopy level by the study group in the exploiting habitat. They often travelled in the range between 100 and 600 m per day, and the ranging patterns were influenced by the food distribution, sleeping site, predation and territorial factors. The study group seems to use areas that are close to human settlements because of the availability and high distribution of food. The study group does not seem to move far from their home range because they will be returning to the trees along the roadside to sleep. Avoiding predators and territorial factor are the main reasons why they are using the same sleeping sites. The most frequent forest canopy strata used by the study group are the ground level (36.78%), followed by the lower canopy (35.46%), middle canopy (17.93%), upper canopy (7.74%), and the lowest is emergent (2%). Overall, ranging behavior of the study group is not only influenced by food distribution but also by other factors such as avoiding predators and territorial possession at the studied area.

Key words: Long-tailed macaque, *Macaca fascicularis*, ranging behavior, Kuala Selangor Nature Park, Peninsular Malaysia

INTRODUCTION

The issues of habitat loss due to logging, development activities and forest conversion for agriculture along with the presence of anthropogenic food resources has created a situation which has affected the behavior and ecology of the monkeys. One of the central pursuits in behavioral ecology is ranging behavior where it is shown in the manner of individuals and groups struggle to obtain, utilize, and defend their home ranges (Börger *et al.*, 2006). The ways primates respond towards their environments varies widely. In order to measure ranging behavior, this research has been focusing on two measures: the annual home range and daily path length. Home range refers to areas that are most frequently used (Burt, 1943), measured using a variety of techniques and it can be interpreted conceptually or operationally (Powell, 2000). Concept model of an animal home range focuses on familiarity and usage. Operating model may accurately reflect an individual's cognitive map, which includes all areas an animal has travelled and can be an important consideration for conservation managers. However, both of these models reflect the demographic and ecological conditions which are important for a better understanding of how animals adapt to the environment (Börger *et al.*, 2006) and may help explain the development of cognitive map (Peters, 1978). In addition, an understanding of how

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animals move through their habitat can help us to fully understand the way they conceive and perceive their world (Powell, 2000). A more concrete concept related to daily path length is how far the animal can tell us about the way individuals and groups have to navigate through their environment. It is often represented as an average or mean length moved throughout a day. Furthermore, although daily path length may reflect more immediate circumstances that prompted the movement of animals, many social and environmental conditions that affect daily path length also affect home range. Many studies have aimed to further understand these conditions.

Each individual and group moves in the area for their daily needs such as feeding, resting, basic social activities, and safety requirements (Chapman and Chapman, 2000). The species that live in a habitat has affected the range area and the daily travelled distance (Leonard and Robertson, 2000). There are a number of studies, which have shown on the effect of food availability, trophic levels, and dietary niches on animal ranging (Clutton-Brock and Harvey, 1977; Robinson and Redford, 1986). Furthermore, the general pattern confirms on the importance of diet on ranging in studies, which has shown that carnivores have a greater range than other animals while frugivores have larger ranges than folivores (Wrangham *et al.*, 1993). In addition, the elements of food distribution and abundance (Clutton-Brock, 1977), forest structure (Gautier-Hion *et al.*, 1981), and the dry and rainy seasons (Li *et al.*, 2000) could affect the animal ranging behavior.

Primate groups often have home ranges that overlap with the neighbouring groups as well as other species. Thus, primates have many strategies to control their ranging area and all of them affect their movement patterns (Isbell, 1983; Kinnaird and O'Brien, 2000). In many strategies, territoriality is the extreme and most likely to occur when the resources are in limited circumstances, and in areas where resources are economically defensible (Mitani and Rodman, 1979; Lowen and Dunbar, 1994). Territoriality should be seen as defending an area of interest that exceeds the cost of defending it. When the cost of patrolling and territoriality is too high, the groups can change strategies such as from avoidance to confrontation, or use long-distance call to locate and notify their neighbours of their presence (Kinnaird and O'Brien, 2000). There are several other factors that influence primate ranging behavior such as to avoid parasites (Freeland, 1979), predation (Isbell, 1994), weather patterns (Clutton-Brock, 1977), the previous day movement (Fossey and Harcourt, 1977), and the position of sleeping trees (Rasmussen, 1979) have all been shown to play a role in primate ranging. All these factors reflect a complex set of adjustments that need to be considered for the interaction between ranging behavior with an individual physiology, social conditions, life history traits, and ecology.

Long-tailed macaques (*Macaca fascicularis*) are one of the most widespread primates, occurring in a broad variety of habitats where they are highly opportunistic omnivores (Aldrich-Blake, 1980; Fooden, 1995, 2006; Gumert, 2011). They frequently exploit areas influenced by human settlements and agriculture, often adjacent to the natural forest (Gumert, 2011; Richard *et al.*, 1989; Fuentes *et al.*, 2005; Malaivijitnond *et al.*, 2005). In Peninsular Malaysia, long-tailed macaques can be found throughout the mainland, from the beach to the top of the mountain, mangroves, primary and secondary forest, isolated patches of woodland in built-up areas, orchards, plantations, and fringing forests (Medway, 1978). In addition, nowadays they can be easily found in urban areas (Perhilitan, 2006). Among the places that macaques are easily found in Peninsular Malaysia are at the tourist areas such as Bukit Malawati Kuala Selangor, Templer Park Kuala Lumpur, Penang Botanical Garden, Taiping Lake Garden and Kuala Selangor Nature Park. Long-tailed macaque population in Kuala Selangor Nature Park is distributed mainly along the road at the entrance of Kuala Selangor Nature Park (Hambali *et al.*, 2012a,b) where this area is very close to urbanized areas. According to Sha *et al*. (2009), 50% of long-tailed macaque population, which is living near the road and human habitation, earn their food from anthropogenic food sources. Almost every day food was provisioned by humans to the monkeys in this studied area, either directly or indirectly (inadvertently) through leaving of food items within their reach, such as in garbage bins near to the ticket counter of the local train station. Thus, more food was provisioned by humans during public holidays because more tourists came to Kuala Selangor Nature Park during this period (Hambali *et al.*, 2012a,b). The objectives of this study are to identify ranging behavior of long-tailed macaques at the study area and identify what are the factors that have influenced the behavior. This study is substantial towards the responsible parties such as district council, wildlife officer and conservation managers.

MATERIALS AND METHODS

Study area

The study group was followed for a total of 165 days starting from February 2011 to December 2011 in the anthropogenic habitats, along the road in front of the Kuala Selangor Nature Park, Selangor, Malaysia (101º 14.678'E, 03º 20.335'N) and

including the roads in residential area and small town (Fig. 1). The size of the study area is approximately 0.53 km^2. There are several species of large trees along the road in front of the KSNP, such as *Ficus microcarpa, Ficus tinctonia ssp. Gibbosa, Arenga pinnata*, *Terminalia cattapa*, *Muntingia calabura*, *Acacia auriculiformis, Areca catechu, Bambusa* sp., *Cascabela thevetia, Crytostachys renda, Elaies guineensis, Gymnostoma* sp., and *Lagerstroemia tomentosa*. Furthermore, the species of trees in residential area are mainly composed of *Mangifera indica*, *Musa* spp., and *Artocarpus heterophyllus*. Majority of these trees are natural food items that the study group obtains from their habitat. The landform in the study area is horizontal at the road and residential area while there is a slight slope because the study area is located near to Bukit Malawati, Kuala Selangor. The study area is so close to a residential area that is just a few meters away. As a result, there are varieties of human activities such as walking, jogging, exercising, riding, trading, and feeding of the monkeys. Provisioned item offered by the human to the study group mostly consists of fruits such as mangoes, bananas, langsats, apples and oranges. In addition, the human also give breads, nuts, snacks and sweets to the study group. Apart from a few high and large-sized trees, there are also electric poles and cables between the electric poles, which are often used by long-tailed macaques to move from one place to another. The long-tailed macaques in the study area were more likely moving on the road.

Ranging data collection

Collections of data on the ranging behavior were obtained by using Instantaneous Scan Sampling Method (Altmann, 1974; Lehner, 1979; Martin and Bateson, 1986). This data are related to the horizontal movement of the study group that always stays along the roadside in the daytime at the study area. It was done during the scan every 10 minutes interval by marking the daily movement patterns (Altmann, 1974; Lehner, 1979; Martin and Bateson, 1986; Brower *et al.*, 1989). The data were then used to draw the exact movement path of study group in mimeographed map of the study area. Home ranges of the study group was estimated based on using the minimum convex polygon (MCP) method which is still widely employed (Baker, 2001; Creel and Creel, 2002; Meulman and Klomp, 1999; Rurik and Macdonald, 2003). This method was the simplest way in which helps to draw the boundaries of a home range from a set of location data is to build the smallest possible convex polygon around

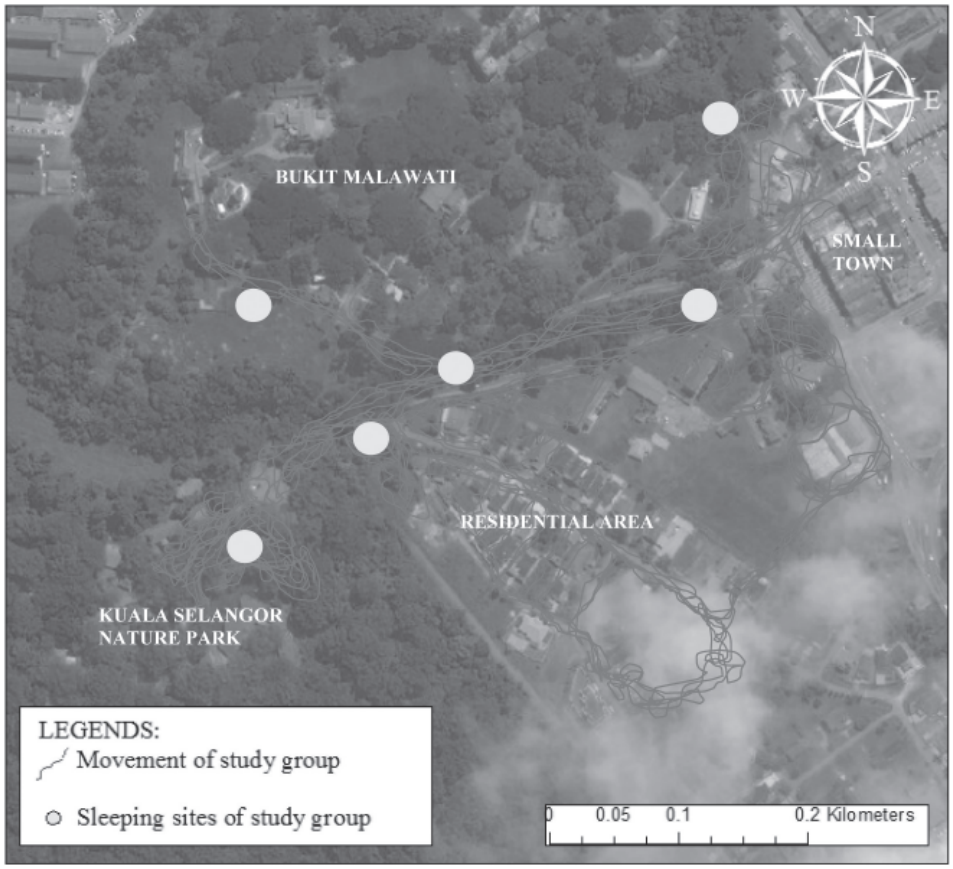

Fig. 1. Map of the study area showing movement pattern and distribution of sleeping sites of the study group.

Table 1. Classification of tree height according to forest canopy strata (Adapted from Whitemore, 1993)

Canopy Strata	Code	Height (m)	Description
Emergence	EM	> 36	Crown of the forest formed by a number of tall trees.
Upper Canopy	UC	26-35	The highest forest strata formed loosely by interconnected tall trees crown.
Middle Canopy	MC	16-25	Middle forest strata formed by tightly enclosed trees crown of medium sized trees.
Lower Canopy	LC	6-15	Lower forest strata formed loosely by sparsely distributed small trees crown.
Ground Level	GR	0-5	Ground level including stream and river banks and understory vegetation consists of herbaceous trees and bushes.

the data. The study group was followed early in the morning (0600 hours) at their sleeping site and ending at another sleeping site in the evening (1800 hours) for 165 days. All of the sleeping sites were identified, marked and mapped via a Global Positioning System (GPS). Vertical movements of the study group were also recorded in each area they went through by using the same method, which is the instantaneous scan sampling method. Height records were classified into five strata of the forest canopy as shown in Table 1 (Whitemore, 1993). During the data recording of this vertical movements was performed, height of members of the study group from the ground was estimated. The data were then analysed using Chi-square, χ^2 Test (Altmann, 1974; Martin and Bateson, 1986).

Focal group

Selection of the study group was made during the preliminary observation. There are two species of monkeys found in the study area, which are *M. fascicularis* and *T. cristatus*. However, this study only focused on one group, which was the *M. fascicularis* species. During the observation made in the study area, there are several groups of *M. fascicularis* living inside and outside of Kuala Selangor Nature Park. In making the group selection, the group must always be present in a same location to ensure that the data can be observed until the end of the study. Some groups of *M. fascicularis* were found around the study area, thus they were then followed. However, not all groups could be followed for a long term because some groups found fled or hid in the forest when they saw the presence of the researchers. There was also a group trying to threaten and chased the researchers because they are considered as a threat to the group. Apart from that, there was also a group, which was frequently present and unpredictable in the study area. This is because these groups do not habituated with human presence.

Results from preliminary observation has discovered a group that was often found in front of the KSNP entrance and have been hovering over the neighbourhood and the nearby town searching for food and causing disturbance. The group was found to be approachable by the researchers and the people. This was indicated by the act of people, which was seen to be giving food to the group, or even have been asking for food from the people. Even so, this group was found to be alert of the threat of predators such as dogs (Fig. 2). The presence of dogs were rarely occurred in the study area, however, the long-tailed macaques were very sensitive animals (always alert) especially against predators by monitoring them from the top of the tree and hear them barking from far. When they saw or heard the sound of dogs, they will warn their group members by voicing out warning sound or by shaking the tree branches, therefore, they were able to escape and find a place to hide. The study group consisted of about 41 individuals as shown in Table 2 (Hambali *et al.*, 2012b). This group has been marked by their alpha-male that has a shorter tail compared with the other group members (Fig. 3). According to Hamada *et al*. (2005), the macaque groups were classified according to the unique characteristics of each individual, the alpha-male and their ranging area. Therefore, this group was selected as the main study group.

RESULTS

Daily ranging

Following the study group during the day has provided detailed information on ranging patterns covering their daily journeys of the study area. Study group was followed from dawn to dusk for 165 days where the daily motion of the study group varies from time to time. Data on day length distance were categorized into 100m intervals to obtain the duration frequency of the day according to that classification. Daily movement patterns of the study group showed that they prefer to travel in a short distance and near to the study area. They frequently travelled in the range between 100 and 600 meters per day. Chi-square test demonstrated that the ratio

Table 2. Age-sex composition of study group at study area

	Adults (9-31 years)		Subadults (4-8 years)		Juveniles (1-3.5 years)		Infants (0-12 months)		Total
Study group	Male	Female	Male	Female	Male	Female	Male	Female	
	4	5	5	6	6	8	3	4	41

Fig. 2. Dogs are the predators feared by the study group.

Fig. 3. Alpha-male that had a shorter tail compare with the other group members.

of daily distance by the study group was significant different (χ^2 = 4194.037, df = 5, p < 0.0001) as shown in Table 3.

Movement patterns and utilization of resource space horizontally by the study group are shown in Fig. 1. It is found that the study group prefers the areas that are close to the forest edge, housing area and town area. They were found to use their home range regularly throughout the study period starting from the entrance of the Kuala Selangor Nature Park to the train ticket counter as shown by the pattern of repetitive usage that eventually have been marked by them as their main areas. In the study area, there are also several types of food sources, specifically trees that were frequently visited by the study group to eat (Fig. 4), thus shaping their movement patterns.

Table 3. Percentage and frequency of the daily distance by the study group

Distance (m)	Observation	Percentage (%)	$\frac{(O-E)^2}{E}$
100	2536	41.16	2217.22*
200	1740	28.24	495.004*
300	877	14.23	21.9085*
400	500	8.11	270.427*
500	373	6.05	416.471*
600	136	2.21	773.01*
Total	6162	100	25675*

*Showed significant differences (p < 0.0001) by using the Chi-square test (χ^2).

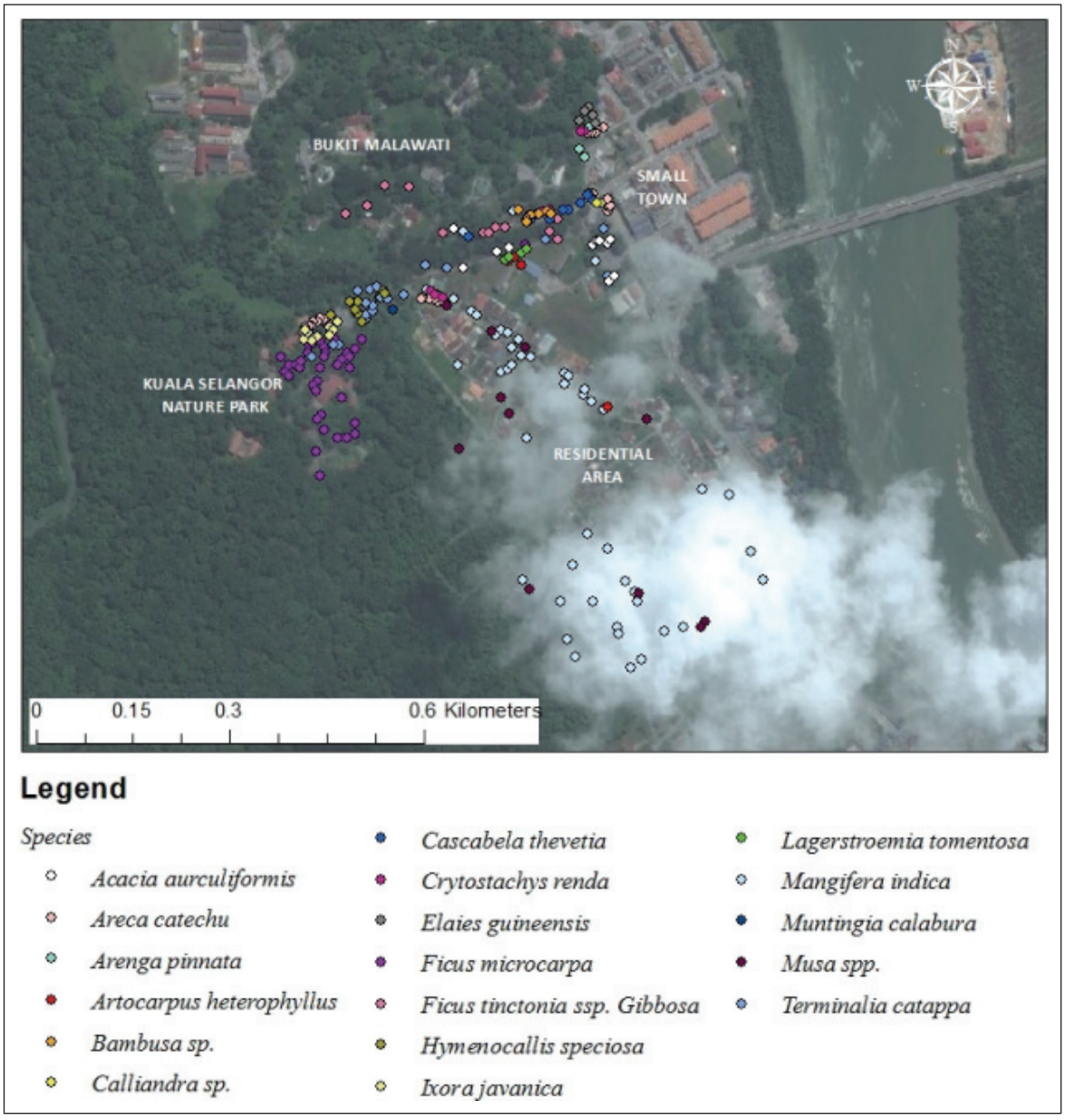

Fig. 4. Food trees frequently visited by the study group to eat.

Among the food trees, which become the favorite food for them were the fruit ranging from the species of *Ficus microcarpa* and *Ficus tinctonia ssp. Gibbosa*. However, the study group that fed more on anthropogenic food spent less time feeding on natural fruits and flowers. These differences could be related to the higher availability of anthropogenic resources and lower availability of natural resources in the home range of the study group.

Data on home ranges of the study group was obtained automatically using global positioning systems (GPS) system. Study group was found to use certain places regularly compared with other places. This clearly shows that they have a territorial nature and were also trying to avoid confrontation with the other macaque's groups. A movement pattern of the study group was also heavily influenced by the availability of suitable trees to support their existence. Although the study group often move on the ground, their movement was always close to the trees or electric poles. This may be caused by the security factor since they have predators, which were dogs that often wander at the study location. Home range for the study group was estimated to be at 0.20 km^2 (Fig. 5).

Distribution of night sleeping sites

During the study, some of the sleeping sites of the study group were identified at the study area. The sleeping sites were marked based on the findings of the study group in the morning when the study began and in the evening where the study group stopped at the last place to sleep. Sleeping locations of the study group was near to the place where they usually find their food and was easily predicted by the researchers. Sleeping sites of the study group usually focus on the big and tall trees especially the *Ficus* species that are found in large

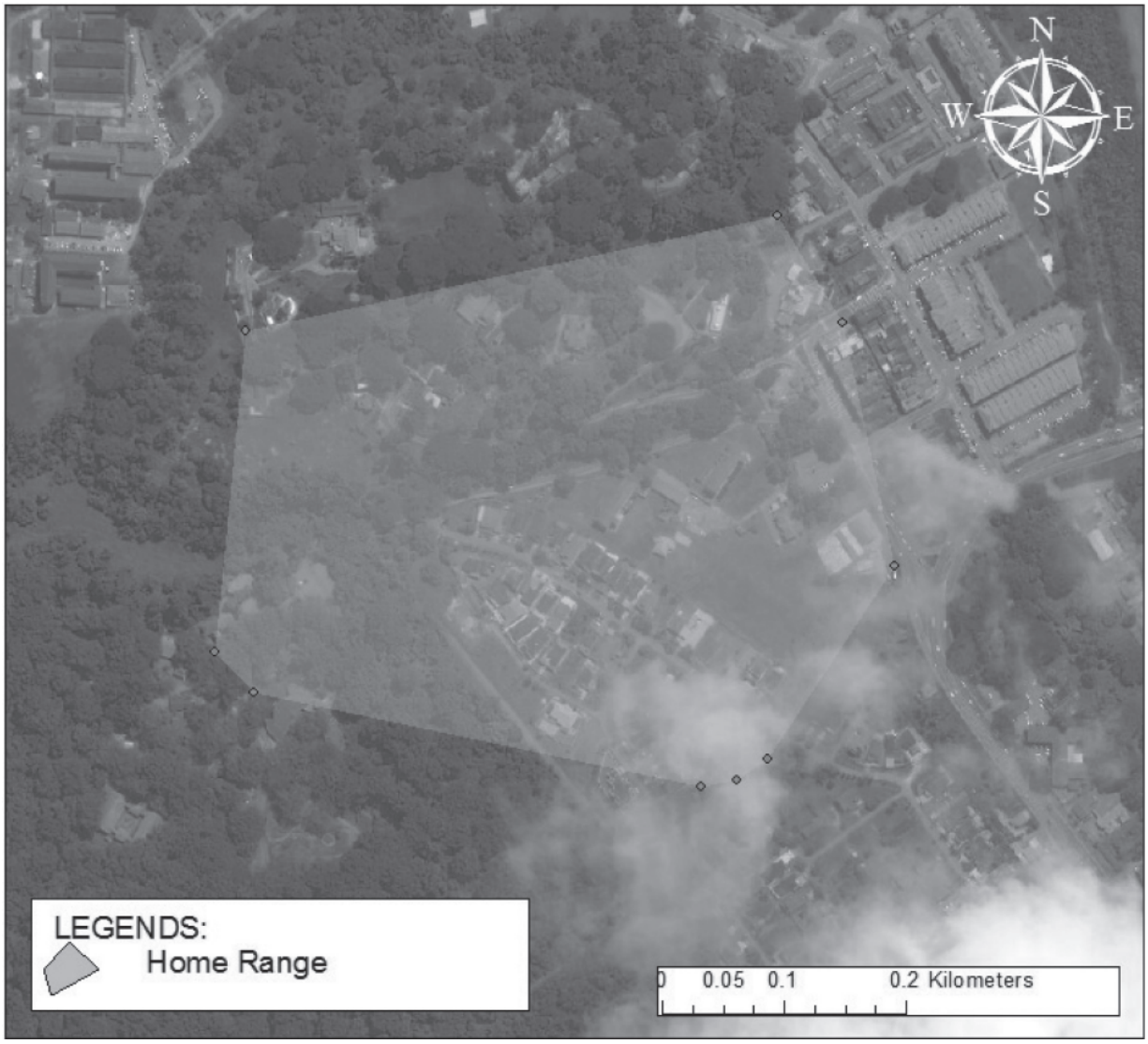

Fig. 5. Home range areas by the study group.

number at the study location. This is to protect themselves from being eaten by the predators that are usually active at night.

The study group strictly chose and entered their sleeping site at dusk and only there were a few sites used repeatedly (Fig. 1). Besides, the study group will avoid sleeping at unusual or unknown places. This shows that the study group has low flexibility in the context of choosing their sleeping sites. It was found that this study group would not share their sleeping sites with another group of monkeys and also other species which is the lutong (*Trachypithecus cristatus*) that was also found at the study locations.

Use of different forest canopy strata

The usage of the stage canopy by the long-tailed macaques is very much dependent on the structure and forest composition in an area. Record of the canopy usage by the study group is shown in Figure 6. It was found that the study group mostly preferred to use the ground level followed by the lower canopy, middle canopy, upper canopy and the very least at the emergent trees. Long-tailed macaques dominate more on the usage of the ground level (36.87%), lower canopy (35.46%), middle canopy (17.93%), and upper canopy (7.74%). It was found that the study group rarely chose the emergent trees where they only exist based on the records at that level which is only 2%. Chi-square test demonstrated that the ratio of the usage at the trees canopy level by the study group are considered to be a significant different ($\chi^2 = 4506.201$, df = 4, $p < 0.0001$) as shown in Table 4.

RESULTS AND DISCUSSION

Long-tailed macaques are social animals that travel in groups. This is to ensure that members of the group can easily hear the vocal warnings if there are predators in the environment (Hambali *et al.*, 2012a). For the mothers of long-tailed macaques, they are found to carry their baby when in moving process and always control them while playing for ensuring the safety of their baby (Md-Zain *et al.*, 2010; Hambali *et al.*, 2012a). They often do daily activities together such as moving, feeding, resting, grooming, playing, vocalization, mating and fighting (Hambali *et al.*, 2012a). Movement is the most important daily activity done by the long-tailed macaques compared with other activities throughout the day (Sia, 2004; Suhailan, 2004; Md-Zain *et al.*, 2010; Hambali *et al.*, 2012a). Following the study group during the day has provided detailed information about their daily travel in the study area. Daily movement patterns of the study group shows that they prefer to travel in a short distance and near to the study area. Such effects reflect the higher nutritional content and accessibility of anthropogenic food resources. This matched with a study conducted by Sha and Hanya (2013) which stated that the average daily movement of long-tailed macaques in the high anthropogenic (1.80±0.13 km) and in the low anthropogenic (1.48±0.10 km).

During the study period, the favorite spot for the study group to perform daily activities such as feeding, resting, grooming, sleeping and others was at the edge of Kuala Selangor Nature Park starting from the entrance to the train ticket counter (Hambali *et al.*, 2012a). This is due to the nature park environment, which is surrounded by residential areas and urban areas; the study group included both nature park and urbanized areas in their home range. The preferable habitat for the study group could be seen by the most frequent usage and used repeatedly as shown in Figure 1. Movement of the study group in this study site was in a group, where adult monkeys would move first, followed by the sub-adult monkeys and juveniles. Usually, newborn baby monkeys and still in breastfeeding period is brought by her mother under the belly or above the body (riding). However, adult monkeys will always observe and ensure their group members are safe when they are moving. When they stop to eat, they will split up and find their own food. Many studies have shown the relationship between daily journeys

Table 4. Percentage and frequency of the usage of trees canopy level by the study group

Canopy Strata	Observation	Percentage (%)	$\frac{(O-E)^2}{E}$
Ground Level (GR)	3316	36.87	1279.68*
Lower Canopy (LC)	3189	35.46	1074.41*
Middle Canopy (MC)	1613	17.93	19.19*
Upper Canopy (UC)	696	7.74	676.1*
Emergence (EM)	180	2	1456.81*
Total	8994	100	28780.8*

*Showed significant differences ($p < 0.0001$) by using the Chi-square test (χ^2).

with the food availability patterns. Usually, primate will have long distance journey because of the shortage of food (Marsh, 1981; Davies, 1984; Boonratana, 1993; Menzal, 1996). For example, Hanya *et al*. (2002) found that *Macaca fuscata* in Japan were reported to be performing a long distance journey from its habitat of origin during long winter that was caused by the shortage of food. McKinney (2011) found that food-enhanced capuchins maintained a much larger territory than wild conspecifics. Campbell-Smith *et al*. (2011) found that crop-raiding orang utans travelled further on days when they raided crops than on days when they consumed only wild fruits. Similarly, Hockings *et al*. (2012) reported that chimpanzees increased their traveling and feeding time on days when they crop-raided. Compared to their wild counterparts, food-enhanced primates often have smaller home ranges and shorter day ranges, and spend less time traveling and feeding and more time resting (Altmann and Muruthi, 1988; Forthman Quick and Demment, 1988; Kogenezawa and Imaki, 1999; Saj *et al.*, 1999). These various patterns highlight the complexity of primate ecological responses to food enhancement, which may depend on species and individual group and site conditions (McKinney, 2011; Hockings *et al.*, 2012).

However, our findings slightly differed from the results of wild counterpart above where it was found that the study group who live at the forest edge and closer to human settlements (anthropogenic area) have smaller home ranges and shorter daily ranging distances and the study group spend more time moving compared with resting. This study also supports the research conducted by Sha and Hanya (2013) which stated that in the high anthropogenic group, they spent less time resting and more time moving. The difference in the activity budget and home range could reflect the nature of food sources available to the macaques as well as indicating how they utilized them. In this study, it was found that the main food for the study group composed of anthropogenic food sources (food at residential areas, garbage cans at the study location and food that is frequently given by human). Anthropogenic food sources for primates include plantation crops, human habitation, waste depository sites, and direct human provisioning (Altmann and Murathi, 1988; Saj *et al.*, 1999; Strum, 2010; El Alami *et al.*, 2012; Hockings *et al.*, 2012; Riley *et al.*, in press). The inclusion of human food sources has significant effects on the ecology of many primate species (Else and Lee, 1986; Fa and Southwick, 1988).

In addition, other factors that influence the study group's movement pattern are selection of sleeping site at night. Sleeping sites of the study group usually focus on the big and tall trees especially the *Ficus* species that are found in a large number at the study location. This is to protect themselves from being eaten by the predators that are usually active at night. Although no observations was carried out at night to look for the presence of predator, the predator that have been known to be active at night and inhabiting the study area are leopard cats (*Prionailurus bengalensis*) (Hambali *et al*., 2012a,b). During the present study, it was found that the amounts of sleeping sites used by the study group were not much in number and very limited at the study site (Fig. 1). Besides, the big size of the study group which is around 41 in numbers consist of different ages and sexes (Hambali *et al.*, 2012b) also play a major role in influencing the limited sleeping site. Larger group had limited number of sleeping sites, thus using them repeatedly (Maklarin, 2008). This shows that the study group has low flexibility in the context of choosing their sleeping sites. The study group was found to move from their sleeping sites as early as at 0800 hours and return at the sleeping sites at 1800 hours. It was found that the choice of sleeping sites is also one of the strategies in preserving their energy in order to move for long distance to find new sleeping sites. Besides, according to Ramakrishnan and Coss (2001), the choice for not wasting its energy shows that the group will not have any problems with the predators by sleeping at the new sites. They will avoid sleeping at unusual or unknown places. This is one of the ecological aspects or an important strategy that is used by the study group for survival. This may be caused by the territorial factor and also to avoid any form of competitions and fights.

Long-tailed macaques are arboreal animals where they also use the level of canopy trees to move vertically. Therefore, other than horizontal movement, they also need a vertical movement to use every stage of the canopy trees for eating, resting, grooming, sleeping, shading, and also protecting themselves from the predators. Vertical movement allows the primates to explore the different height of trees that supply different source of food (Ungar, 1996). The usage of the stage canopy by the long-tailed macaques is depending on the structure and forest composition in an area. This matter is also similar with the usage of ground areas by the primates where they need to adapt and be careful with any movement and actions towards their environment. In this study, it was found that the study group spent most of its time at ground and lower canopy compared to other level of canopies (Fig. 6). The study group was also found to be not moving from one tree to another tree by jumping, but they preferred to move in quadruped either on the ground or on the electric cable (Fig. 7). This is very dependent on the habitat environment of the primates. The main food choices of the study group were food waste in the garbage cans (Fig. 8), the

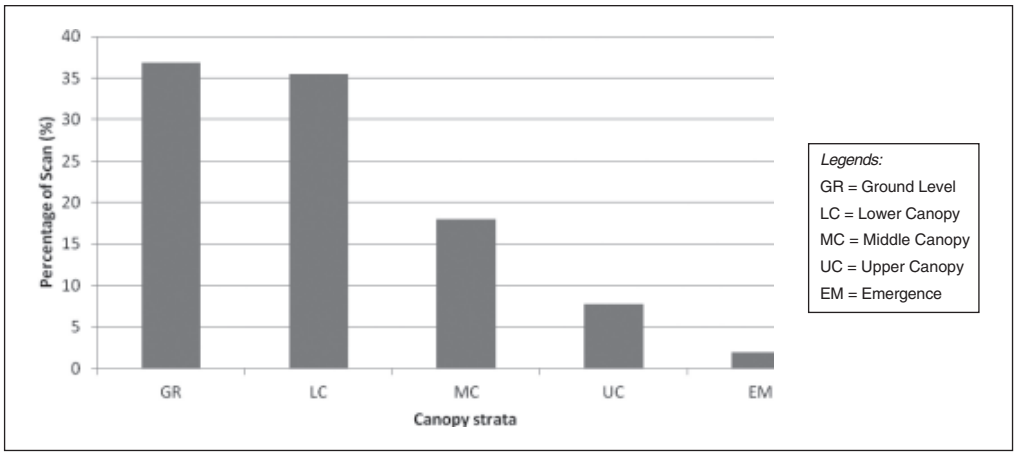

Fig. 6. Pattern of canopy use by study group.

Fig. 7. Using electric cable to move from one area to another area.

Fig. 8. The main food choices of the study group were food waste in the garbage cans.

Fig. 9. The food given by humans.

Fig. 10. The food from the residential areas nearby.

food given by humans (Fig. 9) and the food from the residential areas nearby (Fig. 10) which have made them revolutionized the use of the ground level compared to other levels of the tree canopies.

Overall, the data of the study on the ranging behavior have been successfully identified in all the daily routes of the study group and these routes are very closely related with the pattern of food distribution at the study locations. Meanwhile, the study location that was located at the edge of the forest bordering the human residential areas and town also provided sources of food from food waste by human and also the human plants. The larger or wider distribution of food makes greater ranging area. Human activities such as feeding the macaques, littering everywhere and not maintaining cleanliness in their residential areas are some key factors in influencing their wide range of movements as well as causing disturbance to people. Therefore, it is proposed that enforcement should be conducted by giving penalty to any party who deliberately feeding the macaques and do not maintain cleanliness of their home area. This has been practiced in our neighbouring country, which is Singapore. In addition, agencies such as Universiti Putra Malaysia (UPM), Wildlife and National Park Department (PERHILITAN) and Malaysian Nature Society (MNS) should initiate awareness programs for the local people nearby and also for the tourists. Public awareness campaigns such as giving talks and

creating more signboards such as "Do not feed the monkeys" and "Do not litter" can be initiated to cater this issue. Besides, the absence of predators or biological control also causes the movement of study group without limits. Therefore, it has been observed that the macaques were afraid of the presence of dogs at the study area. They will run away and climb up the trees to save themselves when they came across the dogs. Thus, it is highly recommended that the authorities can create a "dog patrol units" whereby are trained to control and drove the macaques from disturbing the residential areas and tourist attraction areas. This technique has been practiced in Uganda to protect their farm with patrolling the area with dogs, spears and bells to get rid of baboons (Hill, 2000). Finally, study on this ranging behavior have to be carried out in the future because the primates have a very high ability to adapt in the residential areas or disturbed habitat especially for the species of long-tailed macaques. However, the urban residents can still live in harmony with the wildlife such as the long-tailed macaques specifically with appropriate and balanced ecosystem established by the local authorities.

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